



# BEYOND ALGEBRA: HIGH SCHOOL MATH FOR A NEW GENERATION

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## ABOUT JUST EQUATIONS

Just Equations reconceptualizes the role of mathematics in ensuring education equity for students. An independent resource on the equity dimensions of math education in the transition from high school to college, Just Equations advances evidence-based strategies to ensure that math

policies give all students the quantitative foundation they need to succeed in college and beyond. Just Equations' work is currently supported by College Futures Foundation and the Bill & Melinda Gates Foundation.

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# BEYOND ALGEBRA: HIGH SCHOOL MATH FOR A NEW GENERATION

## EXECUTIVE SUMMARY

### THE WORLD IS RAPIDLY CHANGING. DATA AND TECHNOLOGY ARE UBIQUITOUS.

Math education needs to keep up with these changes so that all students can acquire the quantitative skills they need to succeed and contribute to society. Parents have called for math education to be more relevant to the real world (Jimenez, 2023). Now, as states and districts seek to elevate learning and prepare more students for work in the digital future, they have not only a unique opportunity, but also an urgent imperative, to redesign high school math.

This report examines an array of education policies that exert considerable influence on the **math students learn** and **when they learn it**, factors that have a profound influence on students' futures.

These policies include:

- + **High school graduation requirements.** State requirements range from two to four years of math. Some mandate specific courses, such as Algebra II, while others allow more variation, including updated versions of Algebra II.
- + **Placement policies.** Some policies allow students to begin their high school math sequences during middle school. These accelerated sequences can enable students to take more advanced math courses (including calculus) during high school. But not all acceleration efforts have succeeded and access to these accelerated paths has

disproportionately been denied to students of color and low-income students.

- + **Math standards and frameworks.** Traditionally, these policies emphasized the path through algebra and geometry to calculus. Today, many states are modernizing their sequences, giving students new advanced math options—such as statistics, data science, quantitative reasoning, and mathematical modeling, in addition to the traditional courses—for their third and/or fourth year of high school.

This report shares up-to-date information about how some states are navigating these policies as they develop innovative redesigns of high school mathematics and about strategies aimed at improving student outcomes, particularly for historically underrepresented students. A survey of state math supervisors highlights the priorities driving these changes. For example, 93 percent of respondents said their states are seeking “to align the mathematics curriculum with students’ college and career interests.” A 50-state policy scan illustrates the range of math graduation requirements across the country.

To illustrate various redesign strategies, the report features examples from five states: Georgia, Ohio, Oregon, Utah, and Washington. Drawing from those strategies, the research evidence, and the survey of state math supervisors, it provides insights and recommendations for states and districts to consider as they update their high school math policies.

### INSIGHTS

- + Effective teaching is a hidden variable.
- + Student support is one key to successful and equitable acceleration to advanced courses.
- + Reforms need to focus on course content and actual math learning—not just course titles.

### RECOMMENDATIONS

- + Expand opportunities for students to take four years of math through graduation requirements and increased availability and variety of senior-year math courses.
- + Build consensus on the priorities for modernizing courses such as Algebra II.
- + Provide multiple routes to advanced math for qualified students of all races.
- + Invest in school counselor support and resources to support transitions from middle school to high school and high school to college.
- + Support high-quality professional development to help teachers align instruction with essential content and address the diverse needs of students.
- + Develop a comprehensive evaluation strategy to assess the outcomes of redesigns.

The report also outlines a research agenda on high school mathematics pathways to inform future efforts to expand math opportunity to create equitable and inclusive math learning for all.

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## BEYOND ALGEBRA: HIGH SCHOOL MATH FOR A NEW GENERATION

High school is a time for coming of age, pursuing one's passions, branching out from a common pathway, and charting a new future. Students enter as young teens and emerge four years later with a fresh sense of self and new opportunities. And few things have as extensive an influence on students' sense of self and opportunities as their high school math experiences.

It is therefore no surprise that initiatives to update high school math content and sequencing have been hotly debated in recent years (Schoenfeld & Daro, 2024). On the one hand, the pushback against reforms to improve math learning reflects deep-seated beliefs about how math should be taught and parents' fears that their children will be ill-served by any changes. On the other hand, it illustrates a lack of consensus, even among educators, about how to improve math learning. Building common ground requires raising awareness of existing research as well as expanding the evidence base on the effects of various math-related policies.

The goal is ensuring that math education reflects the needs of a rapidly changing world, so that all students can succeed and contribute to society. Parents are calling for math education to be more relevant to the real world (Jimenez, 2023). Doing so means revisiting an array of education policies that influence what students learn and when they learn

it, and doing so through two interrelated facets of students' opportunities to learn math:

**+ How much math students take.** This is influenced by how many math courses they take during high school, which is partly a function of *graduation requirements*. States require as few as two and as many as four years of math to graduate high school.

But it can also be a function of how students progress through math sequences, including when they begin algebra, considered the entry point of high school math. That, in turn, is a function of *placement policies* that determine whether students can take ninth grade math in middle school to get a jump-start on their math sequences, often with a goal of reaching calculus by their senior year.

**+ Which math courses students take.** Available course options are governed by policies including state *graduation requirements*, *math standards*, and *math frameworks*. For example, Algebra II is offered by schools across the nation, but only 17 states and the District of Columbia consider it a graduation requirement for all students. Increasingly, states are modernizing their

math sequences, by updating existing courses and adding new offerings. In many places, students have new options—such as statistics, data science, computer science, and mathematical modeling—in addition to the traditional algebraic path to calculus.

Collectively, the underlying policies—graduation requirements, placement policies, standards, and frameworks—help shape individual students’ trajectories and future opportunities, as well as the broader architecture of math opportunity in a school, district, or state.

Of course, policies are not the only factors at play. Also key are advising practices, individual schools’ offerings, and choices by students and families—not to mention the all-important role of quality teaching and curriculum. Course names and progressions can often obscure the fact that some students—even some who earn high grades—learn little in their math classrooms. But policies and their implementation signal priorities that extend down to classrooms, influencing how schools, teachers, and families navigate their roles in the math education landscape.

High school math policies also interface with, and reinforce, contexts existing before and after high school: One example is inequitable access to high-quality K–8 instruction (Morgan et al., 2023), which leaves some students ill-prepared for high school math. Another example is the fact that college admissions offices often place a premium on reaching calculus (Anderson & Burdman, 2022; Barnett et al., 2022; Burdman & Anderson, 2022).

Examining the implications of policies on **how much math** and **which math** students take is a starting point for understanding how the structure of high school mathematics has historically exacerbated education inequity. So is analyzing the redesigns that aim to reverse that trend. Based on what we know from prior research, the stakes are potentially very high for students and society.

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## ABOUT THIS REPORT

As schools, districts, and states across the country examine their high school graduation requirements, placement policies, and advanced math course options, it is important to consider the implications their decisions have on students’ college aspirations and opportunities. Yet the research to date has not produced clear recommendations for educators. A deeper understanding of any potential changes and their effects can catalyze collaborative action to foster more inclusive environments that ensure meaningful math learning that supports students to thrive in our data-driven society.

This report explores emerging practices in high school math education and highlights current knowledge on their impact on student outcomes. It treats **equitable participation in and completion of advanced math courses**—that is, rigorous courses designed for the last year or two of high school—as a key measure of success.

This measure includes equitable access to STEM-path courses as well as other courses that align to students’ interests and prepare them for postsecondary success.

To better understand various approaches to high school math sequences and their effects and inform future efforts to improve student achievement, this report will examine existing strategies to expand access to advanced high school math courses and equalize outcomes in mathematics, and raise the following questions:

- + Given the mixed evidence on detracking and acceleration initiatives, can we identify the placement approaches that have the most promise for advancing equitable access and success in advanced courses?
- + What can we tell about how students’ choice of advanced math courses—including both calculus and less traditional courses, such as statistics or data science—relates to their postsecondary outcomes?

## METHODOLOGY

The report utilizes a 50-state policy scan and an 11-item Google Form survey conducted by Just Equations in partnership with the Association of State Supervisors of Mathematics (ASSM) and a review of literature. The survey gathered data on the ongoing efforts of states to redesign

high school math courses and sequences, with a specific focus on improving student outcomes. The survey was distributed to state-level leaders overseeing mathematics education, affiliates of the ASSM. There were 32 valid responses representing 22 states over a three-week period in February

2024. Questions were structured to capture information on state-level initiatives and approaches to redesigning high school math pathways, focusing on topics such as placement policies and course offerings. All quotations from survey responses maintain participant anonymity.

## TERMINOLOGY

This report uses the terms **accelerated math** and **advanced math** as follows:

- ✦ **Accelerated math.** Refers to a course a student takes that is designed for a higher grade level. The most common example is an eighth grader taking Algebra I, but it could also describe a 10th grader taking Algebra II, an 11th grader taking AP Statistics, or a senior taking Calculus.
- ✦ **Advanced math.** Refers to higher-level high school math courses generally available to students in their junior and/or senior year—after (or sometimes in place of) Algebra II. These may include Precalculus, Statistics, Data Science, Calculus, Advanced Placement (AP)

courses, and/or dual-enrollment college courses.

Students pursuing an accelerated path are more likely than other students to reach advanced math. As such, accelerated courses are a strategy for reaching the goal of taking one or more advanced courses.

**Tracking** involves placing students by perceived ability either in different levels of the same course (such as honors, regular, and fundamental) or in courses designed for different grades. **Detracking** is a placement strategy in which all (or most) students in the same grade are assigned to the same course level, regardless of perceived ability or prior performance. Many detracking initiatives involve acceleration, but not all acceleration

initiatives have the goal of detracking.

References to **Algebra II** encompass both the traditional Algebra II course and Integrated Math III. Most schools follow either a traditional course pattern (Algebra I, Geometry, Algebra II) or an integrated pattern (Math I, Math II, Math III). In theory, both course patterns cover the same content, with the integrated sequence blending algebra and geometry content throughout the three years. Under national curriculum guidance and most state standards, both patterns are expected to include statistics content.



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## RESEARCH CONTEXT

A significant body of research has correlated advanced math coursetaking with outcomes such as college preparation, college matriculation, college completion, and future earnings (Adelman, 2006; Dougherty et al., 2017; Joensen & Nielsen, 2009; Riegle-Crumb & Grodsky, 2010; Riegle-Crumb & Humphries, 2012). Virtually all of this research has focused on courses leading to calculus.

Unfortunately, enrollment in higher-level math courses is strongly correlated with demographics. Decades of data consistently demonstrate racial and socioeconomic inequities in math coursetaking patterns, with prior math experiences playing a significant role in students' access to advanced math (Baker et al., 2023; Bronson & Long, 2022; Galanti et al., 2021; National Council of Teachers of Mathematics, 2018; National Science Board, 2018; Patrick et al., 2020).

The pattern becomes apparent during middle school, when underrepresented students are the [least likely to take Algebra I](#). In 2020–2021, only 16 percent of Black and 21 percent of Latinx eighth graders were enrolled in Algebra I, compared with 27 percent of White students and 38 percent of Asian American students. These disparities continue in high school, with only 3 percent of Black students and 5 percent of Latinx students reaching AP math courses in 11th or 12th grade, compared with 8 percent of White and 22 percent of Asian American students.<sup>1</sup>

The disparities are partly explained by structural inequities across schools. In 2020–2021, 39 percent of middle schools in the country did not offer Algebra I (U.S. Department of Education, 2023, p. 5). But racial and socioeconomic inequities within schools point to the presence of systemic bias (Francis & Darity, 2021; Reed Bennett Merritt, et al., 2023; Riegle-Crumb & Humphries, 2012). In fact, as Just Equations and The Education Trust found, prior preparation does not explain

demographic disparities in high school: High-achieving Black, Latinx, and low-income students are less likely to be enrolled in advanced math courses than their White and Asian American peers with comparable preparation (Baker et al., 2023).

States and districts have adopted various approaches to placing students in math courses, and research has not yet produced definitive answers about which approaches are the most equitable and effective. Dialogues about the quantity and variety of students' high school math courses must consider how various practices constrain or expand opportunity, and for whom. Prominent among these practices is tracking.

## PLACEMENT PRACTICES

**TRACKING.** The research on tracking is mixed. While some tracking programs have been shown to benefit high-ability students of color (Card & Giuliano, 2016), tracking often negatively affects Black and Latinx students, significantly limiting their access to advanced math coursework and, consequently, college and STEM opportunities (Francis & Darity, 2021; McCardle, 2020; National Council of Teachers of Mathematics, 2018). Indeed, the U.S. Department of Education updated [Title VI of the Civil Rights Act](#) in 1998 to prohibit course assignments based on race and advised education leaders to match students to courses based on nondiscriminatory criteria.

Yet tracking persists—in math more than in any other subject (Loveless, 2013c). One form involves placing some students in qualitatively inferior levels of a course that may not prepare them for future study (National Council of Teachers of Mathematics, 2018). Another common form that has received policy attention in recent years involves accelerating some students into a higher-level course. The latter is particularly relevant at the juncture between middle school and high school. Many schools have embraced the practice of offering Algebra I, a ninth grade course,

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<sup>1</sup>AP math coursetaking by race was calculated using 11th–12th grade enrollment data from the “Select Grades” field in the 2020–2021 Data: Algebra I Across the Nation data table, along with enrollment data from the Advanced Placement courses, sourced from the Civil Rights Data Collection, Office for Civil Rights, webpage on the U.S. Department of Education website. This data is currently featured on the homepage, but may be relocated in the future.

to some students in eighth grade—and sometimes even in seventh (Galanti et al., 2021). After that point, most systems lack the flexibility for students to move to a higher track (Ngo & Velasquez, 2023).

Biases in high school counseling appear to contribute to tracking (Francis et al., 2019; Galanti et al., 2021; Irizarry, 2021; Riegle-Crumb & Humphries, 2012). Just Equations' 2023 survey on math course access and college admissions revealed that students were more inclined to attribute their high school math course choices to recommendations from school counselors (49 percent) than those from teachers (27 percent) or parents (10 percent) (Smith Arrillaga et al., 2023, p. 12). Furthermore, it found that Black and Latinx students were less likely to receive recommendations from counselors to enroll in advanced math than their White and Asian American peers, and that students whose parents did not attend college were less familiar with college math expectations and requirements than students whose parents did.

**DETRACKING.** While there is no shortage of literature connecting tracking to inequitable outcomes for underrepresented students (Francis & Darity, 2021; McCardle, 2020), attempts at detracking—an approach aimed at equalizing access to math courses—have yielded mixed results (Loveless, 2021). To keep all students on the same path at the same time, detracking generally focuses either on accelerating students (universal acceleration) or on keeping them at grade level.

In the late 1990s, Rockville Centre, a diverse suburban school district on Long Island, reported promising eighth grade outcomes from a universal acceleration effort. The district replaced tracked classes with mixed-ability classes in middle school, placing all eighth graders in Algebra I. As a result, more than 90 percent of the incoming freshmen in 1998 had already passed the algebra-based Regents

exam. The proportion of Black and Hispanic students passing the exam tripled—from 23 percent to 75 percent—while the White and Asian American student passing rate increased from 54 to 98 percent (Burris & Welner, 2005, p. 596).

On the other hand, universal eighth grade algebra policies in North Carolina two decades ago produced a significant negative effect on performance in both Algebra I and Geometry for most students, particularly less-prepared students, and only small positive effects for the highest-achieving students (Clotfelter et al., 2015). Similarly, California's 2008 eighth grade algebra-for-all policy led to a decline in scores on state assessments. Inconsistent implementation and ambiguous messaging to districts were common explanations for the underwhelming results (Domina et al., 2016). Another explanation was that some eighth graders simply weren't ready for Algebra I (Finkelstein et al., 2012; Loveless, 2013a).

However, it is unclear how these examples apply to current students, given that Algebra I is much more advanced today than it was in the 1990s and 2000s (Fong & Finkelstein, 2014).<sup>2</sup>

### **ACCELERATION AND COLLEGE ADMISSIONS.**

Researchers have raised the concern that acceleration is driven by the perceived<sup>3</sup> or real need for students to pursue an advantage in college admissions by taking calculus in their senior year—rather than by an interest in a calculus-intensive field (Anderson & Burdman, 2022; Bressoud, 2021). Only about half of the high schools in the country—and only 35 percent of those with high enrollments of Black and/or Latinx students—even offer calculus (U.S. Department of Education, 2023, p. 6). And even within schools, racial and income disparities in access are extremely common (Francis & Darity, 2021; Riegle-Crumb & Grodsky, 2010; National Council of Teachers of Mathematics, 2018).

Some experts also note that racing to calculus causes students to miss essential content, rather

<sup>2</sup> Per Fong & Finkelstein, "While in 2013/14 a student might have taken a course called 'Algebra I' in grade 8, starting in 2014/15 much of that content has now been rolled into the CCSS-M for grade 7. Meanwhile, the new CCSS-M-aligned grade 8 course is considerably expanded, not only in content but also in rigor. Notably, the 2014/15 course is called 'CCSS-M Grade 8 Math,' not 'Algebra I.'"

<sup>3</sup> A Just Equations report (Anderson & Burdman, 2022) found that few colleges have an outright calculus requirement, but many admissions offices do have a preference for students with calculus on their transcripts. Since the U.S. Supreme Court's 2023 decision to outlaw affirmative action in college admissions, some colleges are reconsidering this practice (Burdman & Baker, 2023).

than developing the foundational skills necessary for success in advanced math (Galanti et al., 2021). One study showed that prerequisite courses for calculus were more important preparation for college than taking a calculus course in high school (Sadler & Sonnert, 2018). Pressure to reach calculus also contributes to hyperacceleration (or “tracking up”) of Algebra I as early as seventh grade, which further stratifies access to advanced mathematics by race and socioeconomic status (Domina et al., 2016; Galanti et al., 2021). For these reasons, the National Council of Teachers of Mathematics (NCTM) cautions against rushing students through critical concepts, while recognizing that acceleration may be appropriate for some students (NCTM, 2018).

## NEW HIGH SCHOOL MATH COURSES



Another challenge for measuring access to advanced math is that state definitions of advanced math are evolving. Traditionally, states emphasized the 130-year-old canonical sequence of Algebra I-Geometry-Algebra II (AGA), with the primary difference among students being *how far* they progressed in this sequence (Daro & Asturias, 2019; Milou & Leinwand, 2022). The addition of courses such as statistics, mathematical modeling, data science, and quantitative reasoning responds to the need to modernize course offerings and better prepare students for various majors (Charles A. Dana Center, 2020).

How the *type* of math courses students take affects

college access and success is a newer question. Understanding the answer is key to ensuring that the new courses serve as on-ramps to future opportunities, not as detours or off-ramps. It has been only a few years since high schools around the country have engaged in expanding the range of math courses available to students. Even high school statistics, which has been offered since the 1990s, has not been the focus of much research focused on student outcomes.

## SURVEYING THE LANDSCAPE: EMERGING PRACTICES

One response to the imperative for more equitable student success has been the movement to reenvision high school mathematics courses and sequences. Recognizing the importance of adapting to the evolving needs of students and society, many states are undergoing significant overhauls in their high school math sequences. Our survey of state supervisors of mathematics sheds light on states' diverse approaches to these redesigns.

Of the 22 states that are represented in our survey, 19 are actively involved in the redesign process—in either the planning or implementing stage—of high school mathematics pathways. The top five guiding goals respondents<sup>4</sup> identified as central to these efforts are:

- + To align the mathematics curriculum with students' college and career interests (92.6 percent of respondents)
- + To enhance student engagement, self-efficacy, and interest in mathematics (92.6 percent of respondents)
- + To address changing needs of the 21st century, particularly in relation to data and technology (88.9 percent of respondents)
- + To tackle disparities in access to advanced math courses for underserved students (81.5 percent of respondents)

<sup>4</sup> There were 32 respondents, 27 of whom answered this question about goals. Some states had multiple respondents.



- + To ensure that more underserved students meet university admissions standards (77.8 percent of respondents)

A majority of respondents also cited improving academic performance and increasing overall enrollment in advanced math courses as key motivations.

Many of the states' approaches are consistent with strategies advanced by the Charles A. Dana Center at the University of Texas at Austin and other initiatives to modernize high school and postsecondary mathematics. The Dana Center coordinates the five-year-old Launch Years Initiative, in which 22 states<sup>5</sup> are involved in design and implementation of mathematics pathways, including aligning high school and college sequences (Charles A. Dana Center, 2020; Lee & Reyna, 2022).

## DESIGN PRINCIPLES

Key literature on these approaches reveals several guiding principles for reforms designed to enhance equity in students' educational experience and outcomes.

- + **Foundational mathematics content and pathways.** Firstly, priority is placed on determining the foundational mathematics content that is essential for all high school students, as well as the optimal timing for transitioning to more specialized courses. This entails striking a balance between providing a solid mathematical foundation for all students and offering pathways tailored to individual goals (Charles A. Dana Center et al., 2022; Daro & Asturias, 2019; NCTM, 2018; Schoenfeld & Daro, 2024). Additionally, modernized mathematics includes foundational content that students can use in their postsecondary lives, regardless of whether they pursue a STEM or non-STEM degree/career. This includes relevant material from quantitative reasoning and data science designed to foster conceptual understanding and problem-solving skills.

- + **Flexibility in high school math course options.** Offering students a choice of advanced mathematics courses allows them to build on their mathematical foundation by selecting those that align with their aspirations and aptitudes while also striving to keep options open for students who might change their interests and goals (Daro & Asturias, 2019; Schoenfeld & Daro, 2024). This flexibility is designed not only to empower students to tailor their educational journey but also to foster a sense of ownership and engagement in their learning (Charles A. Dana Center et al., 2022; Daro & Asturias, 2019; Moussa et al., 2020; NCTM, 2018; Schoenfeld & Daro, 2024; Ohio Mathematics Steering Committee, 2014). Given the risk that flexibility could contribute to unfair tracking, states need to address inequitable tracking practices proactively through systemic levers (Charles A. Dana Center et al., 2022).

- + **Rigorous preparation for postsecondary education and workforce.** Ensuring that high school mathematics curricula align with the expectations of colleges—particularly large, four-year, public institutions—is a paramount focus. This alignment is intended not only to facilitate a smoother transition for students but also to enhance their readiness for the academic demands that lie ahead. All options must meet or exceed the rigor of the traditional math sequence, to secure equity and opportunity for all students (Charles A. Dana Center et al., 2022; Daro & Asturias, 2019; Ohio Mathematics Steering Committee, 2014).

- + **Effective communication and advising.** Effective communication and advising are considered central strategies for envisioning high school mathematics courses and sequences. This includes informing students about the potential consequences of opting out of specific course sequences, as this may affect their eligibility for certain

<sup>5</sup> Twelve of the 22 Launch Years states participated in our survey. Including the 10 Launch Years states that did not respond to the survey, at least half of states are engaged in some form of high school math redesign.

postsecondary opportunities, particularly STEM majors. Clear and comprehensive guidance is seen as crucial to empowering students to make informed decisions about their educational pathways (Charles A. Dana Center et al., 2022).

All 19 of the states that indicated they are redesigning high school math education said they are broadening their offerings with additional math

courses or pathways as envisioned by these design principles. Twelve states are exploring opportunities for students to accelerate their learning, nine are reevaluating their placement practices, and eight said they are actively detracking their math programs to mitigate disparities and promote inclusivity.

This report features examples from five states that have actively engaged in redesigning their high school math policies and offerings in recent years to illustrate how states enact these principles.

## GRADUATION REQUIREMENTS

High school graduation requirements send important messages about the role of mathematics in students' educational journeys. Despite growing consensus that U.S. students need stronger mathematics preparation, states have made varying decisions about the number of years of math a student must take, as well as the specific math content required (Achieve, 2019). Policymakers are often balancing two goals: preparing students for college and ensuring students finish high school.

**REQUIRED YEARS OF MATH.** Some states require four years of math for high school graduation while a few states have no specific requirement at all, leaving the decision up to school districts. According to Just Equations' analysis of state education websites and documents ([available here](#)), math requirements are distributed as follows:

- + Four years.** The 19 states requiring four years of high school math—including Ohio, Georgia, and North Carolina—are concentrated east of the Mississippi. Fourteen of the 19, plus the District of Columbia, specify that those four years should include Algebra II. Some states also stipulate that students take math all four years of high school (meaning that students taking Algebra I in middle school may not opt out of math after their junior year).
- + Three years.** Nearly half of the states, 21, require a minimum of three years of mathematics. These include Oregon, Texas,



New York, and Illinois. Only seven of these states mandate Algebra II.

+ **Two years.** Just three states—California, Maine, and Montana—allow students to graduate with only two years of math. California requires courses through at least Algebra I. The other two states don’t name any specific courses.

+ **Not specified.** Three states—Colorado, Massachusetts, and Vermont—do not specify a default number or type of math courses required for a high school diploma. Connecticut requires nine credits of math and science but does not spell out specific math courses.

In some states, local variation is allowed for districts that wish to exceed the state requirement. In California, for example, Sequoia Union high schools in Silicon Valley and high schools in Sacramento expect only the state-mandated two years. In San Francisco and Los Angeles, students must complete a minimum of three years of math. San Francisco requires Algebra II, while Los Angeles permits some Algebra II alternatives<sup>6</sup> in year three. In Long Beach, all students must complete four years of math, including Algebra II.

As illustrated by California, low statewide requirements allow for wide variation. Such variation contributes to inequity in both math learning and college access. For college admission, the state’s public universities require students to take at least three years of high school math, including Algebra II. Not surprisingly, research has linked requiring more math to more math coursetaking (Charles A. Dana Center et al., 2022). Assuming the courses are high in quality, **requiring more years of math appears to be a potential strategy for ensuring greater equity—and ultimately college access**—in that it minimizes disparities.

<sup>6</sup> Some statistics and data science courses that previously were allowed to count toward the Algebra II requirement for admission to California public universities were recently disqualified by university faculty (see *The Algebra II Dilemma*, p. 15). It is not known how Los Angeles and other districts that integrate the universities’ required course pattern into their graduation requirements will respond.

## OHIO

### ALGEBRA II EQUIVALENTS

Ohio’s high school redesign efforts grew from the state’s postsecondary math reforms, initiated in 2014 (Ohio Mathematics Steering Committee, 2014). That effort found that College Algebra was not meeting the diverse needs of students and the evolving demands of the modern workforce, leading to the development of alternative undergraduate offerings. Similarly, the high school math initiative recognized a need for options in addition to Algebra II.

Since 2014, Ohio has required four years of high school math, including Algebra II or equivalent, for graduation. Among states that use the term “equivalent,” Ohio appears to be alone in defining the term to include courses outside the traditional calculus path, as part of reforms initiated in 2019. Four new courses, developed through extensive stakeholder engagement, provide flexibility in the curriculum and align with higher education expectations (Pachnowski & Cannelongo, 2021).

Districts are not required to offer all four Algebra II-equivalent courses.

They are expected to offer Algebra II and are encouraged to offer at least one other. The four new third-year course options are:

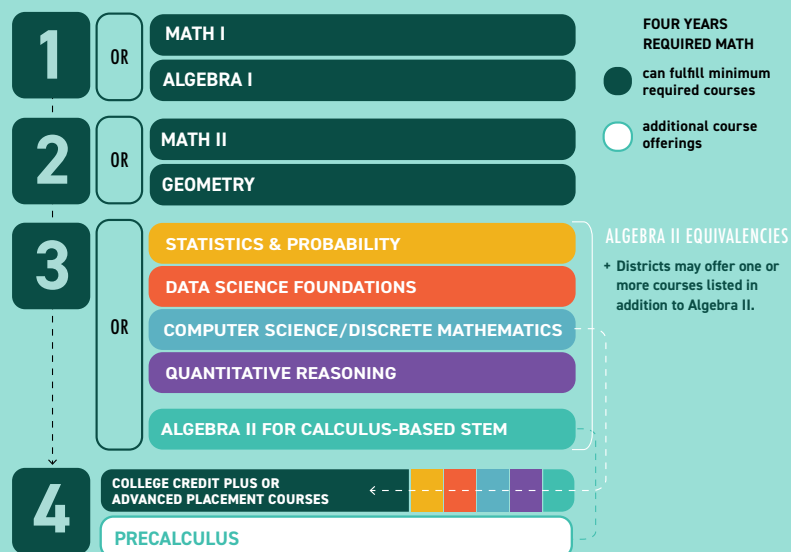
- + Quantitative Reasoning
- + Data Science Foundations
- + Statistics and Probability
- + Discrete Math & Computer Science

Beginning with fall 2024, these courses can fulfill the Algebra II requirement for Ohio public universities. However, students whose intended major requires calculus are advised to take Algebra II. Students who become interested in a major requiring calculus after taking one of the equivalent courses are encouraged to take Algebra II in their senior year.

Key stakeholders involved in this process include an advisory council—comprising representatives from organizations for school administrators, teachers, higher education admissions, and parent associations—and a group of high school and college math faculty.



## OHIO'S HIGH SCHOOL MATH SEQUENCES



Source: Ohio Department of Education

### POTENTIAL CAREERS

#### STATISTICS & PROBABILITY

- + Human Resource Manager
- + Medical Technician
- + Nurse
- + Political Scientist
- + Social Worker
- + Firefighter

#### DATA SCIENCE FOUNDATIONS

- + Software Quality Assurer
- + Journalist
- + Marketing Research Analyst
- + Public Relations Specialist
- + Sales Representative

#### COMPUTER SCIENCE / DISCRETE MATHEMATICS

- + Computer Systems Analyst
- + Computer Support Specialist
- + Cybersecurity Analyst
- + Software Developer
- + Web Developer

#### QUANTITATIVE REASONING

- + Elementary School Teacher
- + Graphic Designer
- + Lighting / Set Designer
- + Musical Composer
- + Technical Writer / Editor
- + Construction Tradesperson

#### PRECALCULUS

- + Doctor / Veterinarian
- + Engineer
- + Farm Manager
- + Financial Manager
- + Scientist

**REQUIRED COURSES.** The treatment of Algebra II is another potential source of variation—and inequity. In recent decades, Algebra II has been seen as a baseline for college readiness (Charles A. Dana Center, 2020; Loveless, 2013a). At the high school level, 19 states consider Algebra II—or Integrated Math III<sup>7</sup>—a graduation requirement (see [50-state policy scan](#)).

Some states' Algebra II requirements are flexible. Eight of the 17 states that require Algebra II or Math III allow alternative courses, waivers, or alternate degrees. Ohio, for example, has four Algebra II equivalent courses (see *Ohio*, p. 13). Some states, including Arizona, New Mexico, and Utah, allow students to take computer science in lieu of Algebra II. Most states that allow waivers require principal permission and/or parental request. One reason for that is that opting out of Algebra II can limit access to certain postsecondary options.

The variations reflect the fact that high school Algebra II requirements have been a focus of debate in recent years. A few decades ago, research linking Algebra II to college-going rates kicked off a movement of states adding Algebra II to their graduation requirements. From 1986 to 2012, the

proportion of 17-year-olds having taken Algebra II grew from 44 percent to 76 percent (Loveless, 2013b, p. 8).

Before long, though, some math education leaders began questioning the value of requiring Algebra II, especially as undergraduate courses such as statistics were growing in importance and prominence. Beginning in 2010, some states—including Texas and Florida—eliminated their Algebra II requirements, while others, such as North Carolina, Arizona, and Ohio, added Algebra II to their requirements (Education Week, 2013).

Policies continue to be in flux. A few years after adding its Algebra II requirement, Ohio modified it to allow other third-year courses (see *Ohio*, p. 13). Since 2019, at least two states have added an Algebra II requirement, while another four eliminated theirs. A fifth, New Mexico, [passed legislation to eliminate](#) its Algebra II requirement for 2025–26 ninth graders while this report was being written.

<sup>7</sup> Only two states—Utah and North Carolina—require schools to offer only the integrated sequence.

## THE ALGEBRA II DILEMMA

Algebra II occupies a critical juncture on the path to college. It is a prerequisite for calculus, a must-have for students who major in STEM. But students who don't end up pursuing STEM—or another field requiring calculus, such as economics—may never use much of the material again.

Furthermore, many students who take Algebra II in high school don't actually learn much Algebra II (Loveless, 2013a, 2013b). Known for covering important concepts such as exponential and logarithmic functions, it is also stuffed with topics that some experts consider obsolete and uninspiring (Daro & Asturias, 2019; Milou & Leinwand, 2022; NCTM, 2018).

Against this backdrop, some education leaders have proposed modifying Algebra II to make it more relevant to students—or replacing it with other courses for students who are not pursuing STEM fields.

Introductory college statistics, a math course commonly taken by humanities and social sciences majors, does not require a foundation in Algebra II (Charles A. Dana Center, 2020). California State University's faculty-led Quantitative Reasoning Task Force underscored this point in its [2016 report](#):

*Statistics is a non-algebra intensive baccalaureate quantitative reasoning course. Recent work suggests that in the context of the California State Standards, to be successful in Statistics a student would need to be proficient in most of the K-8 curriculum as well as in several topics from the Algebra 1 or Integrated Math 1 curriculum.<sup>8</sup>*

In fact, a randomized control study at the City University of New York illustrated that students who didn't pass an algebra test could nevertheless succeed in introductory statistics courses without algebra remediation. The students were 50 percent more likely to earn a two-year degree and twice as likely to earn a bachelor's degree as students who



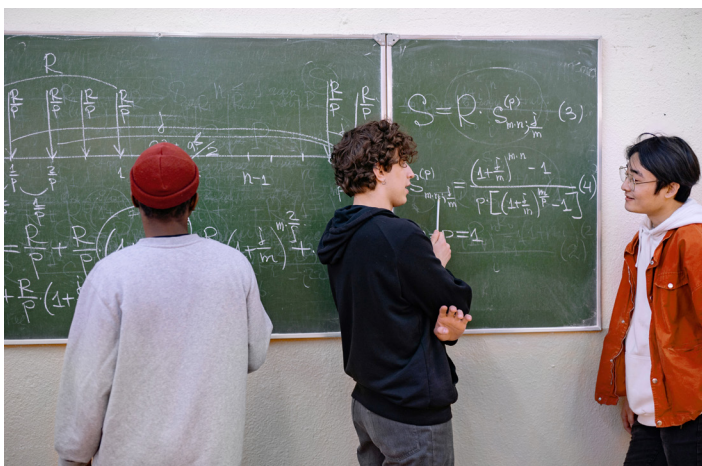
were assigned to remedial algebra courses (Douglas et al., 2023, p. 7–15).

Moreover, UC Berkeley's popular Data 8 course requires [only “basic” algebra](#) as a prerequisite, and its textbook contains no equations (though Berkeley students have Algebra II on their high school transcripts.)

If every high school student had a crystal ball, they could choose with certainty the third-year math course that would best prepare them for their futures. However, not all students decide by 10th or 11th grade what their college major will be, and some of those who do will change their minds. A conservative approach, therefore, has been to require Algebra II—if not for high school graduation, then for college entry.

Increasingly, though, some math experts make the counterargument that many students would be better off taking courses in areas such as statistics, data science, quantitative reasoning, and math modeling (Charles A. Dana Center, 2020). They also argue that the engaging content has the potential to draw some students into STEM fields who would otherwise be turned off by Algebra II, learn very little, and never consider a STEM degree. Students who ultimately pivot to STEM fields can make up ground by taking the corequisite college math courses offered at many universities.

<sup>8</sup> The report did not, however, recommend eliminating Algebra II as an entrance requirement. The focus was on not requiring students to take remedial algebra courses if their subsequent math courses did not build on Algebra II.



Some states, such as Ohio and Oregon, are making such options available to students for their third year of mathematics in lieu of Algebra II or before Algebra II. Others, such as Rhode Island and Utah, require Algebra II but allow students to substitute other courses with parental permission.

**ALGEBRA II AND COLLEGE ADMISSIONS.** College admissions requirements play an outsize role in students' and states' decisions about Algebra II (Barnett et al., 2022; Charles A. Dana Center, 2020). Research has shown that students can succeed in college statistics without knowledge of Algebra II (Douglas et al., 2023; Hayward, 2021). That awareness has contributed to changes in college placement practices around the country. In particular, many colleges no longer require algebra placement tests for students who are meeting their math requirements with a statistics course (Burdman et al., 2018).

However, these patterns have not led to widespread changes in college admissions requirements (Charles A. Dana Center, 2020). Public university systems such as Oregon's have [opened the door to courses other than Algebra II](#) (Anderson et al., 2023), but many others still specify an Algebra II requirement for admission (see *Oregon*, p. 16).

At least one state has been tightening its Algebra II requirement. For more than 10 years, California public universities permitted students to substitute a statistics or data science course for Algebra II, a route chosen by a tiny proportion of students (Burdman, 2023). Under a recent change, data science

## OREGON

### STUDENT CHOICE AND UPDATED COLLEGE ADMISSIONS

Oregon's approach to high school mathematics education is undergoing significant change with its 2+1 Model, adopted in 2021. Currently in early implementation, the model departs from the conventional sequence by requiring a two-year core curriculum focused on algebra, geometry, and data/statistics content (Oregon Math Project, n.d.).

Students choose their third-year course based on their educational and career aspirations. Traditionally, most high schools offered Algebra II for the third requirement, though it wasn't mandated for high school graduation. Now, in addition to Algebra II, students can choose from new course options that align with advancements in computer science, data science, and mathematical modeling, thus making high school math relevant for more students.

While the traditional AGA sequence is still available, the 2+1 model affords districts the flexibility to consider other sequences that align with state standards, such as an integrated sequence or additional third-year options. Though no student outcomes data are available yet, state leaders are convinced that the model has led to increased student engagement, according to one survey respondent.

Oregon education leaders worked with postsecondary education leaders to draft a new policy related to admission that is consistent with Oregon graduation requirements. Under the policy, students must take at least three math courses at the level of Algebra I and above (Anderson et al., 2023; University of Oregon, n.d.).

and statistics can no longer fill in for Algebra II (Fensterwald, 2024). When that decision is implemented in 2025–26, some districts will face a quandary over whether to stop offering the disqualified courses in place of Algebra II. That is because many districts have incorporated the course pattern required by public universities as a default graduation requirement.



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## WHICH MATH: EXPANDING MATH CONTENT

The mathematical demands of the future include more facility with data, statistics, and modeling than the 20th century required. Broadening the scope of mathematics offered in the last year or two of high school is one feature of many high school redesigns. Of the 22 states participating in our survey, 19 states list this as one of their goals. In addition to designing or adopting new, relevant, and engaging courses, this may entail updating existing courses to their modern equivalents.

A common strategy is to require all students to learn foundational content up to 10th or 11th grade, then permit students to choose among rigorous courses that prepare them for college and align with their interests and aspirations. For example, students who are not interested in pursuing STEM majors may find that courses in data science or mathematical modeling better meet their goals.

The work to broaden high school math content is a relatively new outgrowth of initiatives to expand college introductory math offerings. Over the past decade, dozens of state higher education systems have begun encouraging—or requiring—campuses to offer math courses outside of the traditional calculus path for students whose majors don't require calculus (Burdman et al., 2018). These postsecondary initiatives helped set the stage for expanding high school offerings (Charles A. Dana Center, 2020; Daro & Asturius, 2019).

Though new courses are intended to promote higher-order mathematical thinking, their introduction is often met with skepticism. One reason is that, historically, courses outside the calculus path, such as shop math, were often dead-end options (Schoenfeld & Daro, 2024). Another is that traditional definitions of rigor prioritize increasing difficulty and workload, while newer uses add an emphasis on reasoning in authentic contexts (Burdman, 2021; Charles A. Dana Center, 2019; Harding & Levy, 2024).

In Georgia, when an initial effort to create alternative courses to Algebra II was met with pushback, education leaders instead created a modernized version of Algebra II for all students (Amy, 2021). Focused on sense-making, the course integrates traditional algebra content with other topics such as data science (see *Georgia*, p. 18). In California, a new math framework's introduction of data science instruction has continued to roil statewide discussion (Burdman, 2023).



## THE DATA SCIENCE DEBATE

At least [17 states now offer data science](#) courses, which use a blend of statistics and computer programming to analyze real-world data, as a high school math option. At least two of those states—Ohio and Oregon—allow data science to serve as a third-year course or replacement for Algebra II.

There is a rich context for the expansion of these courses: Our modern, data-saturated lives require greater data competency for all, not only for those who will become data scientists. A growing number of [college majors require statistics](#). Most states' new standards—including the Common Core State Standards<sup>9</sup>—have placed an emphasis on students learning about statistics and data. But these topics are often glossed over, partly because teachers are less familiar with how to teach them (Lovett & Lee, 2017; Sparks, 2023). Research indicates that data science and other innovative math courses have the potential to engage far more students in mathematical

<sup>9</sup> Most states that do not use Common Core have adopted their own standards that are similar to Common Core.

pursuits, students who otherwise might never have taken another math course (Bracco, 2021; Heinzman, 2020).

High school data science courses were first offered in the Los Angeles school district in 2014 as part of a National Science Foundation grant and in partnership with UCLA (Burdman, 2015). The courses have garnered growing attention in recent years: The UCLA course, Introduction to Data Science, is now offered in 89 schools across 34 California districts, plus schools in 11 other states. Other popular high school data science courses—all developed at universities—are also growing quickly.<sup>10</sup>

There is little opposition to teaching data science courses in high school in general. But there have been sharp divisions over their place in the math curriculum. Critics fear that some students interested in STEM will be misled into taking data science courses rather than prerequisites for calculus, especially Algebra II (Barak & Mims, 2022). This could have the unintended effect of tracking students out of STEM opportunities—or out of higher education altogether. Proponents counter that statistical reasoning and data competency are essential for all students, whereas Algebra II is useful only for the minority of students who will go on to earn STEM degrees (Gould, 2023). Currently, around [10 percent of 25- to 34-year-olds](#) hold STEM degrees, though the proportion is increasing. Furthermore, they say, such courses can reengage students who have lost an appetite for math and science (Morgan & Suaray, 2024).

Efforts to modernize Algebra II or incorporate algebra in data science courses (Son & Stigler, 2023) point to ways out of the dilemma. Examples of the former include new courses in Georgia and Washington (see *Georgia*, p. 18, and *Washington*, p. 21.)

## GEORGIA

### ALGEBRA II MODERNIZATION

Georgia's education system is conducting a shift in its high school mathematics curriculum to better equip students with the essential skills needed for success in the 21st century. The changes were catalyzed by the 2021 adoption of [new K–12 mathematics standards](#), which were implemented in the 2023–24 school year. While maintaining the state's longstanding four-year math requirement, the new standards provide school districts the flexibility to offer a variety of mathematics courses after Algebra II.

In fall 2023, Georgia introduced an updated Algebra II course, called *Advanced Algebra: Concepts and Connections*, that infuses traditional algebra topics with big ideas such as data, statistical reasoning, and probabilistic reasoning. The course focuses on sense-making, eliminating content appropriate for precalculus, and adding topics such as data science that prepare students who will pursue noncalculus paths. A version integrating Algebra II and AP Precalculus is for students on an accelerated path.

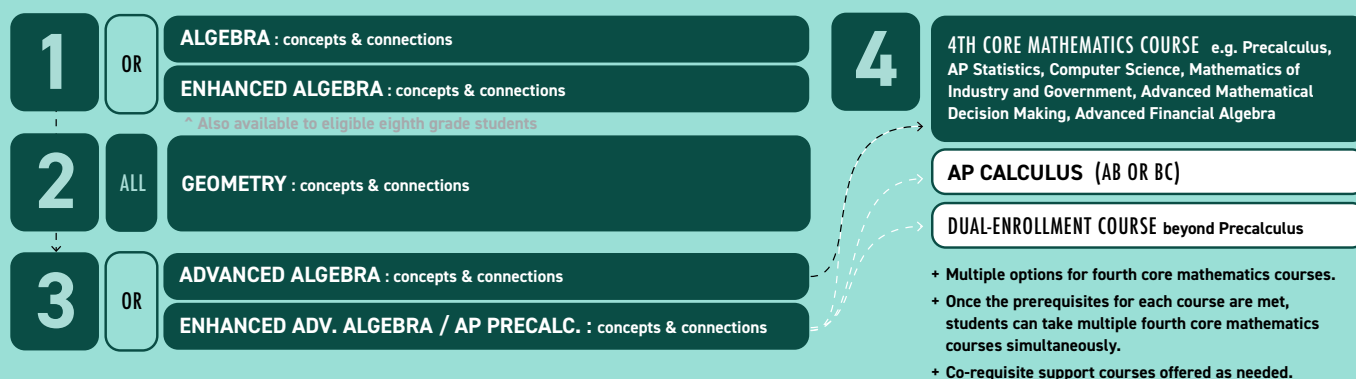
Complementing the core Algebra II curriculum, the state also offers a range of fourth-year course options tailored to students' diverse interests and career aspirations. In addition to standard offerings such as precalculus, statistics, and calculus, examples of offerings include:

- + AP Statistics
- + Computer Science
- + Advanced Finite Mathematics
- + Mathematics of Industry and Government
- + Linear Algebra With Computer Science Applications

As students grow and progress through their academic journey, their personal interests, strengths, and aspirations may evolve. Georgia responded to this concern by establishing multiple junctures where students, parents, and counselors work together to evaluate and determine the most suitable mathematics course sequence for a student's goals and aspirations.

<sup>10</sup> The others are [CourseKata](#), developed at UCLA and Cal State LA; [Explorations in Data Science](#), developed at Stanford University; and [Bootstrap](#), developed at Brown University.

## GEORGIA'S HIGH SCHOOL MATH SEQUENCES



FOUR YEARS  
REQUIRED MATH



can fulfill minimum  
required courses



additional course  
offerings

Source: Georgia Department of Education



## RESEARCHING NEW MATH COURSES AND SEQUENCES

Initiatives to implement new high school math courses and sequences have proliferated in the past five years. Most are still too new to have generated robust evidence about their impact on students' later outcomes—especially postsecondary outcomes for students who opt out of traditional math courses. The majority of research on postsecondary outcomes pertains to calculus coursetaking (e.g., Bressoud, 2017).

Several recent studies in California shed preliminary light on the impact of nontraditional courses on postsecondary outcomes. A report by UCLA suggests that Los Angeles students who took statistics instead of precalculus were more likely than their peers to attend four-year public universities

and persist to the second year; however, the researchers could not rule out enrollment caps in STEM majors at some CSU campuses as an explanation for that finding (Wainstein et al., 2023). The study found no significant difference in college enrollment between seniors who took precalculus and those who chose a nontraditional course, such as Introduction to Data Science.

That study and another (Reed Bennett, Bracco et al., 2023) both concluded that a key advantage of offering more high school math options is that it increases math coursetaking in senior year. Findings by other California researchers (Bracco, 2021; Heinzman, 2020) suggest that some of the courses' benefits come from strengthening students' math identities and confidence.



More evidence about high school data science and other innovative courses should be available in the next few years, as states continue to expand offerings. The resulting research should shed light on their outcomes, particularly as substitutes for Algebra II. In the meantime, there are several places to look for insights.

The first is postsecondary statistics courses. A robust body of research focused primarily on community college students has shown that allowing students to take statistics courses to fulfill their math requirements is associated with positive outcomes—including completion of math requirements, subsequent math courses, two- and four-year degrees, and even workforce outcomes (Carnegie Math Pathways, 2022; Douglas et al., 2023; Ran & Lin, 2022; Rodriguez et al., 2017).



Another area ripe for inquiry is the college performance of students who take statistics in high school. Since AP Statistics was introduced in 1996–97, high school statistics coursetaking has experienced a nearly 30-fold increase (AmStat News; 2017). Given that robust history, there are plenty of longitudinal data on performance of college students who took statistics and not calculus in high school. Analyzing those data could help clarify the longer-term impact of nonalgebraic math sequences, including any effects on AP Calculus coursetaking and postsecondary outcomes.



Understanding the impact is especially important in light of evidence that some selective colleges favor students with calculus on their transcripts, even if the students are not seeking to enter STEM majors (Anderson & Burdman, 2022).

Increasingly, selective universities—including Harvard, Stanford, the University of Chicago, and the University of California—are clarifying that courses other than calculus satisfy admissions requirements for applicants not seeking to study engineering or a similar field (Burdman & Baker, 2023). Data from such universities can also be helpful in understanding the performance of students who take statistics instead of calculus in high school.

For example, an analysis by the University of Illinois Urbana–Champaign found that, in fall 2021, students who had taken statistics as their highest-level high school math course earned first-semester GPAs almost identical to students who had taken calculus as their highest math course. The calculus students—especially those majoring in applied health and engineering—were slightly more likely to remain enrolled for a second semester (Borst & English, n.d., slides 14–15).



## WASHINGTON

### MODERNIZING ALGEBRA II & AUTOMATIC ENROLLMENT

Washington state's high school mathematics education program is shaped by its graduation requirements and recent legislation. Under an automatic enrollment policy adopted in 2019, all high school students who met or exceeded standards the prior year are placed into accelerated math courses, putting them on track to take college-level courses by their senior year (see *Rethinking Math Course Placement*, p. 23.)

The state mandates a minimum of three years of high school math education. After completing Algebra I and Geometry, students have a choice. They can follow a standard sequence and take Algebra II, or they can choose from other options, including:

- + A mathematical modeling course that emphasizes real-world applications covering topics such as health, civic readiness, and finance

- + A quantitative career technical course such as computer science
- + A quantitative-based science course, such as chemistry or physics
- + Linear Algebra With Computer Science Applications

The state is now phasing in its newly designed Modern Algebra II course, integrating data science and quantitative reasoning with essential Algebra II topics. Washington does not mandate Algebra II for high school graduation, but it has been a standard high school course.

When state education leaders considered expanding options, they realized that about two-thirds of students were taking Algebra II as their third-year course. All six of the state's public universities require it for admission. Rural and small schools in particular were less likely to offer multiple options, due to small enrollment and limited

teacher capacity. Therefore, Algebra II became the default choice.

Development of the Modern Algebra II course began in 2019. Rather than focusing only on college readiness for STEM, the developers emphasized the ideas that all students need regardless of their postsecondary plans, as recommended by the Launch Years Initiative (Charles A. Dana Center, 2021). The new course, first piloted in 2023–24, combines essential Algebra II topics with relevant content from quantitative reasoning and data science, and is designed to foster conceptual understanding and problem-solving skills.

The first semester covers traditional Algebra II content, with less focus on algebraic manipulation and an emphasis on conceptual understanding and sense-making. In the second semester, six modules are available across three categories: Modeling With Data, Modeling With

Quantities (which includes trigonometry and financial applications), and Modeling With Algebra (which includes matrices and nonlinear systems). Eventually, students will be able to choose any four of those six. According to state leaders, regardless of modules chosen, the course equips students with the essential math foundation for future courses, whether students take precalculus, statistics, or other courses.

The 2022–23 pilot revealed medium positive effects on students' sense of belonging, engagement, and help-seeking, and a large positive effect on metacognition. Educators who participated in the pilot "universally agreed" that it "significantly improved their teaching methods." They noted that "students found the subject matter more approachable and exhibited improved comprehension across various topics."

The following comments from three participating teachers are illustrative:



*I never liked logarithms, even as a student, and I never liked teaching them.*

*This year, it was all different. They made sense, and we all liked logs.*



*My students had a much easier time understanding rational exponents.*

*They usually really struggle with them, but this year, even though we are just back from the pandemic, it seemed to come to them more easily.*



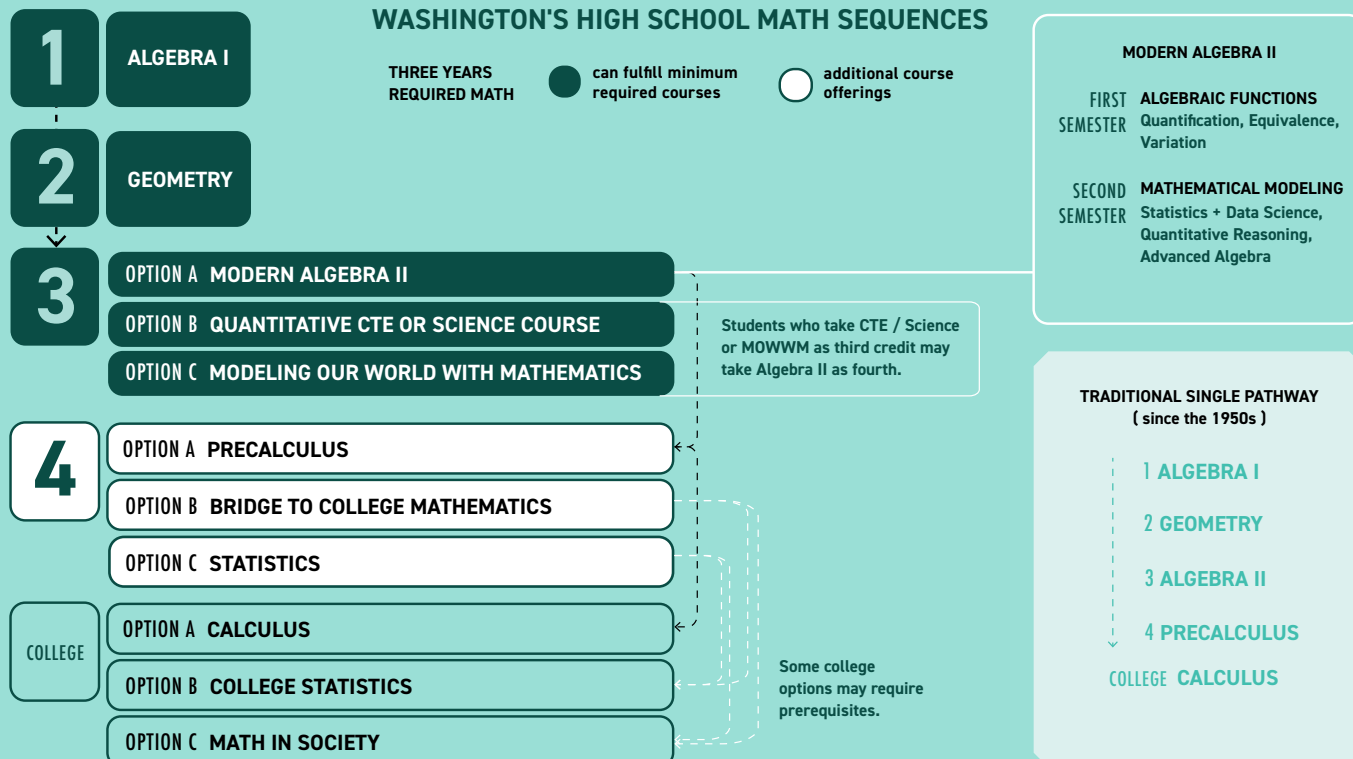
*My students are asking questions like they never did before.*

*Their level of understanding of the content goes deeper to let them do that.*

Student surveys echo these comments, with more than 90 percent expressing heightened confidence in mathematics, problem-solving abilities, and strategies for achieving success.



## WASHINGTON'S HIGH SCHOOL MATH SEQUENCES



Source: Washington Office of Superintendent of Public Instruction





## HOW MUCH MATH: RETHINKING MATH COURSE PLACEMENT

Efforts to democratize math learning and better prepare students for college have prompted some states and districts to consider how students are placed into math courses. In our survey, a large majority of respondents listed tackling disparities in access to advanced math courses as a priority. Of the 22 states, 15 said they were considering some aspect of course placement, including acceleration and detracking.

Eighth grade algebra is a common focus of such efforts. Other routes to advanced math include compressing course sequences (as Utah has done with its integrated sequence) and block scheduling, but many states or districts don't provide those paths.

Over the years, some policy responses to this challenge emphasized ensuring that all students progress through math sequences at the same pace. After California's eighth grade algebra-for-all effort in 2008 failed to meet its goals (Domina et al., 2015), some districts—most visible among them San Francisco—adopted the controversial policy of postponing Algebra I for all students until ninth grade. San Francisco's policy will sunset in 2025 (see *An About-Face on Acceleration in California*, p. 23).

One of the lessons of efforts such as California's was that some students were not ready for algebra in eighth grade, particularly without sustained

## AN ABOUT-FACE ON ACCELERATION IN CALIFORNIA

Following disappointing outcomes from California's algebra-for-all effort (Domina et al., 2015), conversations emerged about deferring access to Algebra I until high school as a different way to address race-based tracking and boost readiness for high school mathematics.

In 2014–15, San Francisco Unified School District did just that, noting that half of Algebra I content had been shifted to eighth grade under Common Core. Rather than omit essential content by having students skip eighth grade math, the district decided to move acceleration from middle school to high school. Students aiming to reach calculus were provided various options, including taking a compressed Algebra II–Pre-calculus course or taking two math courses simultaneously (Tucker, 2015).

San Francisco initially touted this effort as boosting access to advanced math courses in the junior and senior year (NCTM, n.d.; Tucker, 2019). However, the experiment received significant criticism from parent advocacy groups, which feared that eliminating the option of Algebra I in eighth grade would negatively affect their children's math achievement and college opportunities (Tucker, 2015). The groups

disputed the positive results reported by the district. They also complained that the options of compressing courses or taking two at once as an acceleration opportunity were unwieldy, causing some families to seek math instruction outside the district (Ridgeway & Margulies, 2023).

By 2024, San Francisco's school board had voted to revise the 10-year-old detracking policy and reinstate Algebra I as an eighth grade option (Napolitano, 2024). The decision followed a study by Stanford University researchers who found that the strategy did not achieve its stated goal of expanding participation in advanced math either overall or among Black and Latinx students, though it didn't reduce participation either (Huffaker et al., 2023).



support. Seeking to **reap benefits of acceleration without exacerbating racialized tracking**, other states have focused acceleration efforts on high-achieving students across race and based on objective measures, such as grades or test scores. The intent is to avoid reliance on counselors' and teachers' recommendations, which could reflect bias (Francis et al., 2019; Riegle-Crumb & Humphries, 2012), or individual request, which could favor families with more social capital.

Districts in Washington state were among the first nationally to pilot automatic enrollment in accelerated courses for high school students who met standards on state assessments. In 2019, [Washington mandated automatic enrollment](#) across the state, following positive outcomes for underrepresented students in the pilot districts. Data from 72 districts suggested that, from 2014 to 2017, the policy significantly widened access to more rigorous math for underrepresented students, who experienced a 3.1 percent larger increase in participation than their peers (Austin et al., 2022, p. 12).

Legislation adopted in North Carolina in 2018 guarantees accelerated math learning opportunities for students in grades three through 12 who score at the highest level on an end-of-grade test. Like the Washington program, this policy is associated with expanding access to accelerated coursework. In 2017, before the legislation was approved, approximately 10 percent of eighth grade students who qualified for accelerated learning were not placed in accelerated courses. By 2023, the percentage had fallen to 2 percent. In 2023, all but 6 percent of qualifying sixth through 12th graders enrolled in accelerated courses. Racial disparities had narrowed but not disappeared: Among Black and Latinx students, a higher percentage of qualifying students—8 percent—were still not being accelerated (North Carolina Department of Public Instruction, 2023, p. 6; Plucker et al., 2024, pp. 2–4.).

Individual districts around the country are also adopting automatic enrollment policies (E3 Alliance, 2022; Ellis & Hughes, 2021). Since the Dallas Independent School District implemented its

## UTAH

### ALGEBRA II OPT-OUT, MULTIPLE ROUTES TO ADVANCED MATH

Utah requires three years of math education, using the integrated math sequence (Math I, II, and III), for graduation. An extended, or “Plus” sequence—which incorporates precalculus topics into the first three years of high school math—compresses material to allow students to reach calculus as seniors. Most students start Algebra I in ninth grade; only a small proportion of middle school students, who demonstrate mastery of prior standards, are eligible for accelerated sequences beginning in seventh or eighth grade (Utah State Board of Education, 2023). Students can switch between the traditional and extended pathways at any point but must meet prerequisites before taking calculus.

Utah offers a [diverse set of third- and fourth-year course options](#). Three fourth-year options offer college credit through dual enrollment: Quantitative Reasoning, Statistics, and—for students who

wish to stay on a path toward calculus—College Algebra & Trigonometry. Additional options, such as modern math, personal finance, and computer programming, are available as third- or fourth-year choices. Students may take these courses instead of Math III [only with parent acknowledgment](#) that they won't prepare them for dual-enrollment courses.

In 2023–24, the Utah State Board of Education introduced a high school data science course pilot, in which students and teachers at 26 high schools could choose to participate. This course is designed to be an alternative third- or fourth-year high school mathematics course (Data Science 4 Everyone, 2023). The introduction of this course provides students and families with the opportunity to customize their mathematics education based on their interests and career goals.

automatic enrollment policy in 2019, participation gaps in sixth grade honors math among Black, Latinx, and White students have narrowed significantly. In 2019–2020, only 58 percent of Black and 69 percent of Latinx students who met fifth grade-level standards were enrolled in sixth grade honors math, compared with 84 percent of White students. In 2022–23, 92 percent of Black,

94 percent of Latinx and 98 percent of White students who qualified for the program were placed in these courses (Commit Partnership, 2022, p. 18; Napolitano, 2023).

Promising evidence on detracking comes from a more recent study on Rockville Centre’s effort. It found that offering accelerated math to ninth and 10th grade cohorts was associated with significant increases in International Baccalaureate (IB) course enrollments in 11th and 12th grades.

Participation grew to 70–80 percent, up from 20–30 percent (Atteberry et al., 2019, p. 15). Furthermore, high achievers continued to succeed even in heterogeneous classrooms, and the average scores for the school’s lower achievers were the same as before or higher, despite the surge in IB enrollment. According to public reports about state tests, racial and socioeconomic gaps closed over the 14-year period of the study (Atteberry et al., 2019, pp. 36–37).

ADVICE FROM STATE LEADERS ON HIGH SCHOOL MATH REDESIGN

Implementing new high school math pathways requires a strategic approach that engages stakeholders and respects local contexts while maintaining high expectations for student achievement.

State leaders who responded to our survey with ASSM offer the following advice to others seeking to embark on redesigns:

<b>EMBRACE SYSTEM REIMAGINATION THROUGH COLLABORATION.</b>	<b>LEVERAGE EXISTING RESOURCES AND INITIATIVES.</b>	<b>CENTER STUDENT VOICE AND CHOICE.</b>	<b>PROMOTE EQUITY AND INCLUSIVITY.</b>
Approach pathway implementation as an opportunity for systemic reimagination rather than simply fixing existing structures.	Utilize existing frameworks such as the Launch Years Initiative to guide pathway redesign efforts.	Student input and preferences inform math pathways.	Prioritize racial and socioeconomic equity in pathway redesign.
Ensure collaboration between secondary and postsecondary leaders and math educators to adapt and develop relevant math courses and sequences focused on essential mathematical skills and competencies for all students.	Learn from models implemented in other states and leverage resources provided by state professional organizations and educational institutions, such as the ASSM, the NCTM, the Conference Board of the Mathematical Sciences, the Association of Mathematics Teacher Educators, and the National Council of Supervisors of Mathematics.	Routinely conduct student surveys to identify students’ sense of belonging and engagement, and the relevance of their courses to their current interests and academic aspirations.	Analyze student enrollment and completion data to identify disparities. Offer clear information to help students and families choose math courses wisely.
		As an example, Washington state reviewed student coursetaking data and student survey data to inform the design and evaluation of its Modernized Algebra II course.	Thoughtful advising, to ensure students choose options aligned with their interests, is crucial for equitable outcomes. Make sure all students get high-quality math instruction, challenging content, and support for success.
			This means examining courses with a history of demographic achievement gaps.



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## A RESEARCH AGENDA ON HIGH SCHOOL MATHEMATICS DESIGN

While this report cites dozens of studies on various aspects of high school math education, more research is needed to illuminate new approaches being pursued around the country. Further research will go a long way to inform future efforts to open math opportunity to more students, and create more equitable and inclusive math learning environments for all.

**PLACEMENT APPROACHES.** States have adopted a wide range of approaches to middle school acceleration, including the proportion of students participating and how those students are selected. Utah places only 5 to 7 percent of students in advanced math opportunities based on multiple assessment measures (Utah State Board of Education, 2023, p. 2). Texas provides acceleration for students in the top 40 percent based on state tests (Richman, 2023). In North Carolina, the proportion of students qualifying for acceleration, by earning the highest level on state tests, ranges from 33 to 100 percent across schools (Plucker et al., 2024, p. 4). Though California abandoned its eighth grade algebra-for-all policy, Minnesota has [required all eighth graders](#) to take Algebra I since 2008 (Post, 2013).

Early evidence on the outcomes of automatic enrollment into accelerated courses for the highest-achieving students is promising. But if the goal

is to narrow or eliminate racial gaps in completion of advanced math courses, placement is just a start. Ensuring students' progression to higher-level math by senior year is a longer-term investment.

*Under what conditions does placing students in accelerated math courses lead to greater completion of advanced high school courses at equitable rates?*

More longitudinal research is needed to understand the long-term outcomes—including high school and college outcomes—of such policies. Studies on the design of successful programs would inform future efforts. For example, states have chosen various starting points for their automatic enrollment programs, from third grade through high school. *Is there an optimal time to start, for maximizing success and reducing racial and socioeconomic gaps?*

Another question is what definition of “high achieving” most effectively balances the goal of maximizing access to accelerated paths while admitting only students who are prepared to succeed in those paths. Research can also illuminate what practices contribute to success. For example, *what lessons can be learned from Minnesota’s more than 15-year experience with mandating eighth grade Algebra I?*

Lastly, evidence that counselors are influential in students' math course enrollment (Baker et al., 2023; Smith Arrillaga et al., 2023) while some educators hold deficit views about student capacity (Steele et al., 2016) suggests a need for future research to understand the counseling and advising practices that can help optimize math enrollment decisions.

**ADVANCED MATH COURSES.** Research is also needed on the postsecondary performance of students who took nontraditional courses in high school. A starting point would be students who took statistics rather than precalculus or calculus in high school, since years of data are available on such students.

More understanding is also needed about the long-term outcomes of students taking Algebra II equivalent courses in states such as Ohio and Oregon (or



California students who took data science instead of Algebra II in the 10-year period during which universities accepted such students) compared to students who took Algebra II. Some research shows that students who take Algebra II in high school perform better in community college math classes than those who don't (Hayward, 2021), a measure of correlation, not causation. The students who didn't take Algebra II in high school were generally not taking any math course, so it is not known how they would have performed had they taken a different rigorous course.

The research should also examine new, modernized versions of Algebra II, which have begun to show promise (see *Washington*, p. 21). The focus should not be on measuring STEM-course success for students with and without calculus. Students interested in STEM majors are generally advised to pursue a calculus path; no alternative to calculus has been proposed. A more relevant question is how successful the noncalculus-path students are in earning degrees in their chosen fields. Other key questions are: *What advising or other approaches ensure that race and gender are not major factors in students' choice of math pathway, to ensure greater diversity in STEM fields? And how do students on a noncalculus trajectory fare if they change their minds and decide to major in STEM?*

**MATH LEARNING.** A significant body of research focuses on students' progression through math courses at various levels, but less research sheds light on actual teaching and learning. This issue is important, though, because so often access to advanced math courses has been a function of privilege rather than talent. Furthermore, expanded access to courses does not always translate to increased learning (Loveless, 2013a, 2013b). One measure of learning in a math sequence may be success in subsequent high school or college courses (Quarles & Davis, 2017), but to ensure that placement practices and new math courses truly add value, additional research should examine whether students acquire the intended skills and knowledge (and, indeed, what assessment strategies are best suited to measuring their learning).







## KEY INSIGHTS

Though there is not yet a robust body of evidence on varying approaches to high school math sequencing and content to provide definitive guidance for states and districts, several things stand out to the authors as insights for math leaders to keep in mind.

### EFFECTIVE TEACHING: A HIDDEN VARIABLE

Math course offerings and sequencing have the potential to affect student outcomes. But curricular changes alone will not eliminate disparities in high school mathematics achievement. For example, 10 years after the introduction of Common Core, which held the promise of improving equitable outcomes, vast inequities still persist in access to rigorous coursework and math outcomes overall (U.S. Department of Education, 2023).

Inequitable access to experienced teachers plays a large role in explaining disparities (Cardichon et al., 2020). Research also highlights the significant impact of teacher instructional practices (Corkin & Ekmekci, 2019; Hoge, 2016; Osborne, 2021). Pedagogical shifts toward conceptual understanding are important for student learning (Hiebert & Grouws, 2007; Yu & Singh, 2018). Instructional methods used by teachers are strongly correlated with students' math achievements (Wenglinsky, 2002). One example is the Common Core's eight standards for mathematical practice. Research has linked teachers' emphasis on these

practices to improved math outcomes (Allensworth et al., 2021).

Teachers' beliefs—particularly their beliefs about mindset (i.e., whether intelligence is fixed or malleable)—greatly affect student learning (Gutshall, 2016; Yeager et al., 2022). Creating positive learning environments that support students from diverse backgrounds is crucial for students' success (Kroeper & Murphy, 2020; Priniski & Thoman, 2020). Purposeful implementation of instructional and support strategies helps bridge learning gaps and rebuild confidence for students who have faced challenges with their mathematical identities.

Teacher support, which involves creating emotional connections with students, positively influences students' math self-efficacy and interest, indirectly affecting achievement. Notably, student achievement influences perceived teacher support, indicating a reciprocal relationship (Yu and Singh, 2018). Therefore, nurturing teacher–student relationships and fostering supportive classroom environments are crucial for enhancing student motivation and achievement in mathematics.

Students in advanced math courses benefit from teachers and counselors who set clear goals and high standards, fostering supportive and welcoming learning environments (Baker et al., 2023; Bradley-Lambright, 2016; Irizarry, 2021). High-achieving Black students who participated in advanced math courses are more likely to have had caring teachers and



counselors who dedicated substantial time to college preparatory activities. Moreover, underserved high achievers who take advanced math courses experience teachers who focus on deepening their students' understanding of mathematics and emphasizing logical structures, problem-solving skills, and math reasoning (Baker et al., 2023; Irizarry, 2021).

Professional development can improve math teachers' pedagogical content knowledge, enabling teachers to explore various teaching approaches and address students' prior understanding effectively (Adams et al., 2023). It is especially important when teaching content, such as statistics, that is new to teachers (Lovett & Lee, 2017).

### **STUDENT SUPPORT: ONE KEY TO SUCCESSFUL AND EQUITABLE ACCELERATION**

When acceleration initiatives and the factors that may have contributed to the success of some approaches are examined, support structures and resources personalized to meet the needs of students appear to play a role.

In some cases of successful acceleration (including universal acceleration), tailored supports such as high-dosage tutoring have been key (Wolfe et al., 2023). The Rockville Centre program offered specialized support for less-prepared students beginning in middle school and continuing through high school (Atteberry et al., 2019). Instead of simply replacing traditional tracking systems with mixed-ability classrooms, universal acceleration programs can also provide comprehensive support mechanisms to boost students' confidence and the skills needed for achievement in higher-level math. Academic support and increased instructional time for more challenging coursework can help bridge knowledge gaps and promote more equitable learning environments (Darling-Hammond & Cook-Harvey, 2018; Nickow et al., 2020; Robinson et al., 2021).

School districts can also partner with nonprofit organizations to empower and support students from diverse backgrounds in accelerated math programs. The Brookline school district in Massachusetts teamed up with The Calculus

Project—a nonprofit aimed at increasing participation and success of underrepresented students in advanced math—to help students reach their STEM and selective college goals. Programming begins in middle school and extends through senior year (Schwartz, 2023b). In 2014, The Calculus Project reported that the number of Black 10th graders enrolled in the district's Algebra 2 & Trigonometry honors course had quadrupled in one year. As a result, 38 percent of Black students were on track to reach Calculus Honors by 12th grade (Mims, n.d. slides 5–6).

A Tulsa, Oklahoma, school district provides another example of targeted in-school support promoting equitable access to advanced math education. After enrolling promising students from diverse backgrounds into accelerated sixth grade math classes, the school district doubled math learning time from 45 to 90 minutes and provided tutoring for students selected for higher-level learning (Morton, 2024).

More research is needed on the type of support that is most effective and to understand the experiences of students who participate in these interventions, especially those from underrepresented groups. By exploring how different support structures affect student outcomes, educators can tailor interventions to better meet the specific needs of students.

### **LEARNING: PRIORITIZING COURSE CONTENT OVER COURSE TITLES**

Much of the discussion around access to rigorous math courses has focused on titles of courses, but there is some danger in this. First of all, course titles don't necessarily reflect what students are learning (Loveless, 2013b). As Dougherty et al. (2006) wrote:

*A company selling an orange-colored beverage under the label “orange juice” can get in legal trouble if the beverage contains little or no actual juice. But there are no consequences for giving credit for Algebra 2 to students who have learned little algebra.*

*In some cases, the problem is the lack of a standard definition of the content of an Algebra 2 course; in other cases, districts and states lack measures of whether the defined content has been taught and learned; in still other cases, students receive credit for courses even though available measures indicate that they have not mastered the course content.*

Course titles can also cause confusion: During recent debates over high school data science courses in California, critics complained that the state had no data science standards. However, the courses met existing statistics standards with the addition of computer programming (instead of using the graphing calculators traditionally employed in statistics classes). Thus, the absence of standards was a red herring. Similarly, discussions over eighth grade algebra since the adoption of Common Core have also generally failed to recognize that the current eighth grade math course includes about half of the previous Algebra I course (Finkelstein et al., 2012).

Another problem with course titles is that they tend to be associated with yearlong blocks of content, making the courses more resistant to updating (Schoenfeld & Daro, 2024). Within Common Core, the three years of core high school math were supposed to integrate statistics content, but such content is typically shunted to the end of each school year, if it is covered at all (Sparks, 2023).

Keeping curriculum relevant in an evolving world requires making courses more modular—or at least, more flexible—per Schoenfeld and Daro (2024, p. 1299) in *Science*:

*A forced choice between algebra II and data science serves no one: Ideas and content from both areas are likely to be needed in future curricula. ... Much of the tension between the two courses comes from the perception that such courses are monolithic entities.*

*A modular approach, in which students experience aspects of algebra and data science, could allow students to experience components of both content areas through middle and high school.*

Innovations to build in flexibility have already begun. Modularized approaches such as Washington’s new Algebra II course (see *Washington*, p. 21) allow teachers and students to mix and match content with aligned learning goals. Block scheduling is one way to allow students to choose their pacing through math sequences, providing opportunities to accelerate. So is the type of compression adopted by Utah.

Another modularization strategy breaks up courses into small units for which students earn badges. The XQ Institute and Student Achievement Partners are working with three states—Idaho, Illinois, and Kentucky—to [pilot this approach](#). Students earn badges by demonstrating their competency in specific units, which cover more than a single standard but less than a full-year course (Cole, 2023).

A badge for quantitative reasoning focuses on learning to “make sense of and solve real-world problems by strategically using tools like proportionality and percentages, geometric measurement, and data displays.” Its prerequisite is basic arithmetic concepts. For another badge, for modeling with two-variable measurement data, students “pose and analyze meaningful statistical questions that yield two-variable measurement data ... [and] reason with scatter plots, equation models, and quantitative methods.” Its prerequisite is a linear equations badge.



## RECOMMENDATIONS

Research will eventually provide clearer answers about how various math-related policies can best support enhanced math learning, including how much math and which math states should support students in learning. However, based on existing evidence, there are numerous steps that education leaders can take today:

**EXPAND OPPORTUNITIES FOR STUDENTS TO TAKE FOUR YEARS OF MATH.** Graduation requirements are an important strategy to ensure students receive the math preparation needed for their futures. At least three years should be required, but four is even better. Whatever the requirement, states should invest in expanding the availability, quality, and variety of fourth-year courses to ensure that more students benefit from taking math throughout high school. In addition to traditional courses, offerings such as statistics, data science, and discrete math can provide rigorous, real-world learning experiences and prepare students for a wide array of careers.

**BUILD CONSENSUS ON THE PRIORITIES FOR MODERNIZING ALGEBRA II OR OTHER THIRD-YEAR HIGH SCHOOL COURSES.** A math education leadership organization, such as the NCTM, the National Academies, or the Dana Center, should organize high school and college math educators from around the country to identify the key content that is needed for all students and recommend places for culling the curriculum to leave more space for topics such as data and statistics. The focus should be on mastery of critical concepts, including statistics, as opposed to course titles. Ensuring that students are adequately prepared for college and careers includes an emphasis on the eight mathematical practices.

**PROVIDE MULTIPLE ROUTES TO ADVANCED MATH FOR QUALIFIED STUDENTS ACROSS RACE.** This includes providing equitable access to appropriate acceleration, without sacrificing mastery of essential content. Automatic enrollment strategies using objective placement criteria and opt-out



enrollment reduce opportunities for teacher or counselor bias. Other routes to advanced math include block scheduling and compressed courses. Tutoring, online tools, and other supports should be provided to ensure students can succeed. At least seven states currently require schools to offer math support as early as elementary school (Schwartz, 2023a).

**INVEST IN SCHOOL COUNSELOR SUPPORT AND RESOURCES IN MIDDLE AND SECONDARY SCHOOLS.** This includes aligning high school and college advising strategies to improve the transition from high school to college, especially for schools with higher proportions of underserved students. Underserved students may need additional guidance about the implications of their math course-taking decisions. Increasing counselor-to-student ratios can support students who are less familiar with the college admissions landscape. So can preparing counselors to understand the needs of students from historically excluded backgrounds. Students who are on track to reach calculus or other advanced math may need guidance to avoid missing out on competitive postsecondary and STEM opportunities.

**SUPPORT HIGH-QUALITY PROFESSIONAL DEVELOPMENT.** School districts should provide ongoing professional development to help teachers align instruction with essential content and postsecondary expectations, incorporating strategies

that address the diverse needs of underrepresented students. Successful professional development in math education involves clear standards, and opportunities for educators to improve their teaching and expand their knowledge of new math content. This includes hands-on learning, collaborative teamwork, and a focus on student outcomes, with recommended strategies such as aligning curricula, evaluating teaching methods, and fostering collaboration.

**DEVELOP A COMPREHENSIVE EVALUATION STRATEGY.** Do this to assess the implementation and outcomes of math redesign initiatives. This requires an investment in longitudinal data systems to follow students from high school into college and careers. The ultimate measures should be students' participation and success in advanced math courses—including precalculus, statistics, and calculus—by the end of high school, as well as postsecondary outcomes, such as enrollment in two- and four-year institutions and STEM programs. Interim measures depend on the specific redesign but should focus on completion of specific benchmarks, such as Algebra I. All outcomes should be disaggregated by demographic factors such as race, gender, and income. Findings from the quantitative analyses as well as student and teacher surveys should be used to inform professional development and ongoing implementation of the strategy.



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